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What is Claimed is:

       1.   Apparatus for automatically matching a portal image with a simulation image, said apparatus comprising:

       means digitizing said portal image and simulation image to generate digital portal image signals (DPIS) and digital simulation image signals (DSIS), respectively;

       processing means processing said DPIS and said DSIS to generate matched DPIS and DSIS; and

       output means for generating an output from said matched DPIS and DSIS.

       2.   The apparatus of Claim 1, wherein said processing means comprises coarse alignment means generating coarse aligned DPIS and DSIS from said DPIS and DSIS, and fine alignment means generating said matched DPIS and DSIS from said coarse aligned DPIS and DSIS for overlapping regions of said simulation and portal images.

       3.   The apparatus of Claim 2, wherein said coarse alignment means comprises means selecting corresponding seed points in said portal image represented by said DPIS and said simulation image represented by said DSIS, means computing a transform between said portal image and said simulation image from said corresponding seed points, and means applying said transform to one of said DPIS said DSIS to generate with the other of said DPIS and DSIS said coarse aligned DPIS and DSIS.

       4.   The apparatus of Claim 3, wherein said means selecting corresponding seed points comprises interactive means selecting corresponding points in displays generated from said DPIS and DSIS.

5.   The apparatus of Claim 3, wherein said means selecting corresponding seed points comprises means detecting x-ray opaque fiducials in said DPIS and said DSIS, and means identifying corresponding fiducials in said DPIS and DSIS as said corresponding seed points.

5   6.   The apparatus of Claim 3, wherein said fine alignment means comprises means generating prepared DPIS and DSIS from said coarse aligned DPIS and DSIS, means generating an updated transform from said prepared DPIS and DSIS, and means applying said. updated transform to one of said coarse and prepared DPIS and DSIS to generate said matched DPIS and DSIS.

10   7.   The apparatus of Claim 2, wherein said fine alignment means comprises means generating prepared DPIS and DSIS from said coarse aligned DPIS and DSIS, means generating an updated transform from said prepared DPIS and DSIS, and means applying said updated transform to one of said coarse and prepared DPIS and DSIS to generate said matched DPIS and DSIS.
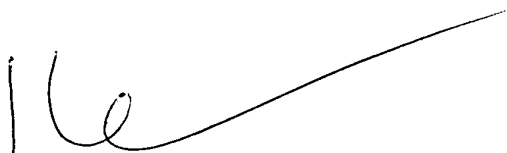
15   8.   The apparatus of Claim 7, wherein said means generating said prepared DPIS and DSIS comprises means selecting selected DPIS and selected DSIS for regions of images represented by said DPIS and DSIS which intersect.

9.   The apparatus of Claim 8, wherein said means generating said prepared DPIS and DSIS further includes means enhancing said selected DPIS and
20   DSIS.

10.   The apparatus of Claim 9, wherein said means selecting said selected DPIS and selected DSIS further includes means selecting DPIS and DSIS within a portion of regions of images represented by said DPIS and DSIS, which have a predetermined regular shape.

25   11.   The apparatus of Claim 7, wherein said means generating said updated transform comprises means generating motion flow components from said prepared DPIS and DSIS and calculating means calculating said updated transform from said motion flow components.

12.   The apparatus of Claim 11, wherein said means generating
30   motion flow components generates motion flow gradient components, and said calculating means comprises means applying a robust optimization to calculate said updated transform.

13.   The apparatus of Claim 12, wherein said means generating said updated transform comprises utilizing said means generating motion flow gradient components and said calculating means repetitively using successive ascending levels of resolution of said prepared DPIS and DSIS.

14.   The apparatus of Claim 7, wherein said means generating said updated transform comprises means using successive ascending levels of resolution of said prepared DPIS and DSIS to generate said updated transform.

15.   The apparatus of Claim 7, wherein said means generating said updated transform comprises means applying robust motion flow to said prepared DPIS and DSIS.

16.   The apparatus of Claim 15, wherein said means applying robust motion flow to said prepared DPIS and DSIS applies robust motion flow to successive ascending levels of resolution of said DPIS and DSIS.

17.   The apparatus of Claim 1, wherein said output means comprises display means generating a display from said matched DPIS and DSIS.

18.   The apparatus of Claim 1, wherein said output means comprises tracking means tracking movement in said image represented by said DPIS.

19.   The apparatus of Claim 18, wherein said output means further includes positioning means positioning a patient relative to a radiation beam which generates said portal image, and means controlling said positioning means in response to movement tracked by said tracking means.

20.   The apparatus of Claim 18 wherein said output means includes means controlling generation of a radiation beam producing said portal image in response to movement tracked by said tracking means.

21.   Apparatus   for   matching   portal   images   to   control radiotherapy/diagnosis equipment, said apparatus comprising:

means digitizing successive portal images to generate successive sets of digital portal image signals (DPIS); and

tracking means tracking movement between successive sets of DPIS.

22.   The apparatus of Claim 21, wherein said tracking means comprises means generating an updated transform between successive portal images by

applying robust motion flow to said successive sets of DPIS and means using said updated transform to track said movement between said successive sets of DPIS.

23.   The apparatus of Claim 22, wherein said means generating said updated transform comprises means generating motion flow components from said successive sets of DPIS, and means calculating said updated transform between successive portal images using said motion flow components.

24.   The apparatus of Claim 23, wherein said means generating motion flow components generates motion flow gradient components, and wherein said calculating means comprises means applying a robust optimization to calculate said updated transform.

25.   The apparatus of Claim 24, wherein said means generating said updated transform comprises means utilizing said means generating motion flow gradient components and said calculating means repetitively using successive ascending levels of resolution of said successive sets of DPIS.

26.   Apparatus for automatically matching an x-ray image with a reference image, said apparatus comprising:

means digitizing said x-ray image and reference image to generate first digital image signals and second digital image signals, respectively;

processing means processing said first and second digital signals without input of any physical dimensions of any features within said images to generate matched digital image signals; and

display means generating a display from said matched digital image signals.

27.   The apparatus of Claim 26 wherein said processing means comprises coarse alignment means generating coarse aligned digital images signals from said first and second digital image signals, and fine alignment means generating a transform between said coarse aligned digital image signals for overlapping regions of said x-ray and reference images utilizing robust motion flow, and means applying said transform to one of said coarse aligned digital image signals to generate said matched digital image signals.

28.   The apparatus of Claim 27 wherein said fine alignment means comprises means enhancing said coarse aligned digital image signals to generate prepared coarse aligned image signals having similar dynamic ranges and intensities,

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and means generating said transform between said prepared coarse aligned digital image signals utilizing robust motion flow.